Hideaki OHBA*: **Additional notes on Burmese Sedoideae (Crassulaceae)****

大場秀章*: ビルマのマンネングサ亜科補遺

Previously I published a paper on the Sedoideae of Burma (Ohba 1975). In that I enumerated 10 species of Sedoideae under the genus *Sedum* in sensu latissimo. After that I have examined several undetermined specimens of Sedoideae collected by late F. Kingdon-Ward in Burma by the courtesy of the British Museum (Natural History). As the result, two species are newly found to occur in Burma. And, I have also examined the type of *Sedum victorianum* Jansson from Mt. Victoria, which excluded from the previous enumeration. On the other hand I proposed a revised system of the Old World Sedoideae (Ohba 1978). Thus, I make corrections and additions to the previous enumeration based on the system, and give some notes on the taxonomy and distribution.

Revised enumeration of Burmese Sedoideae

1. **Rhodiola bupleuroides** (Wall. ex Hook. f. et Thoms.) Fu in Act. Phytotax. Sin. Addit. **1**: 124 (1965).

Sedum bupleuroides Wall. ex Hook. f. et Thoms.: H. Ohba in J. Jap. Bot. **50**: 354 (1975).

2. **Rhodiola chrysanthemifolia** (Lév.) Fu, l.c. 127—H. Ohba in J. Fac. Sci. Univ. Tokyo, Sect. III, **12**: 380 (1980).

Sedum ovatisepalum (R.-Hamet) H. Ohba: H. Ohba, l.c. 358 (1975).

3. **Rhodiola dumulosa** (Franch.) Fu, l.c. 119—H. Ohba, l.c. 401 (1980).

Specimen examined. Hills E. of the Nam Tamai (27°50′N 97°50′E), alt. 9-10000 ft. Forming mats on the bare granite cliffs along the ridge. Fls. cream (Kingdon-Ward 12956, BM).

Distr. Tibet, Burma, Yunnan, Szechuan, Kansu, Shensi, Shansi, Hopei and Mongolia.

4. **Rhodiola macrocarpa** (Praeger) Fu, l.c. 125.

Sedum macrocarpum Praeger: H. Ohba, l.c. 357 (1975).

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** This study was supported by Grant-in-Aid for Co-operative Research No. 434036 in 1980 and 1981 from the Ministry of Education, Science and Culture, Japan.

5. **Rhodiola nobilis** (Franch.) Fu, l. c. 120.

Sedum nobile Franch.: H. Ohba, l. c. 358 (1975).

6. **Rhodiola venusta** (Praeger) Fu, l. c. 121.

Sedum venustum Praeger: H. Ohba, l. c. 358 (1975)

7. **Rhodiola yunnanensis** (Franch.) Fu, l. c. 126.

Sedum yunnanense Franch.: H. Ohba, l. c. 359 (1975).

8. **Sedum amplibracteatum** K. T. Fu: H. Ohba, l. c. 354 (1975).

9. **Sedum filipes** Hemsl. apud Forbes et Hemsl.: H. Ohba, l. c. 354 (1975).

Specimens examined. Hills E. of Nam Tamai Valley, alt. 7000 ft. On wet mossy rocks in deep shade in moss forest. Fls. white (Kingdon-Ward 13080, BM); l. c. (Kingdon-Ward 13473, BM).

10. **Sedum Kingdonii** H. Ohba, l. c. 355 (1975).

11. **Sedum multicaule** Wall. ex Lindl.: H. Ohba, l. c. 358 (1975).

12. **Sedum Oreades** (Decne.) R.-Hamet in Bull. Soc. Bot. France **56**: 571 (1909)—Fröd. in Act. Hort. Gothob. **6**: append. 42 (1931)—K. T. Fu in Act. Phytotax. Sin. **12**: 53 (1974).

Specimen examined. Nam Tamai Valley, alt. 12000 ft. On very barren scree. Fls. yellow (Kingdon-Ward 13347, BM).

Distr. Kashmir, Nepal, Sikkim, Bhutan, Tibet, Assam, Burma and Yunnan.

13. **Sedum victorianum** Jansson in Act. Hort. Gotob. **27**: 7, fig. 1 & 2, Pl. 1 & 2 (1964).

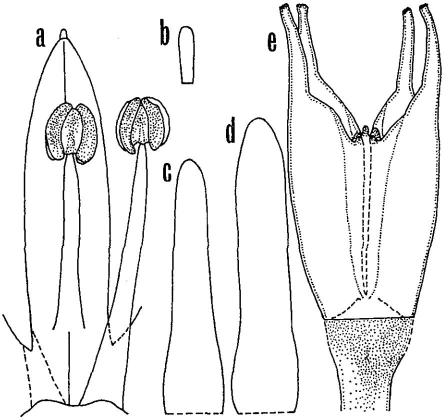

Fig. 1. *Sedum victorianum*. a: Petal with stamens. b: Nectar-scale. c & d: Calyx-lobes. e: Ovaries. All ×10.

Specimen examined. Cult. in Hort. Bot. Gotob. Plantae ex Burma, Mt. Victoria, coll. Kingdon-Ward in Jun. 1956 (Jansson s. n. 15 July 1962, GB-Holotype).

Correction and addition of the description on the flowers (Fig. 1): Flores hermaphroditi, 5-meri, in vivo 14-20 mm diametro, basi ex pedicello indistinguntur. Sepala viridia, glabra, laevia, succulenta, linearia-lineari-lanceolata (-lineari-oblanceolata), paulo inaequalia, 4-6 (in sicco 3-4) mm longa, in sicco 0.7-0.9 mm lata, basi leviter (longitudine in sicco ca. 0.8 mm) connata et ecalcarata. Petala lutea, lineari-lanceolata-lanceolata, apice obtusa, basi longitudine 0.6-0.8 mm connata, 6-9 (in sicco 4.5-5.5) mm longa, 2-2.5 (in sicco 1.1-1.2) mm lata, tenuia, glabra, patentia per anthesin. Stamina numero 10, longitudine 4/5 petalorum aequatia, filamentis filiformibus, obcompressis, flavo-viridis, erectis, oppositipetalis ca. 1 mm supra basin orientibus, in sicco 2-2.5 longis, alternipetalis 3-3.5 mm longis; antheris basifixis, late ovatis, apice paululum sinuolatis, ca. 0.8 mm longis, ante anthesin saturate luteis. Glandulae complanatae, lineares-anguste oblongae, in sicco 0.7-0.8 mm longae, ca. 0.3 mm latae, apice rotundatae vel truncatae. Gynoecia in sicco 4-5 mm longa; ovario erectiusculo per anthesin, latere ventrali longitudine supra 4/5 partis connato, stylo ca. 1 mm longo, apice in stigma sat obscurum papillatum desinente; placenta submarginali, funiculo 0.2-0.3 mm longo. Ovula in quoque loculo numero semper 2. Semina linearia, ca. 1 mm longa.

Jansson (1964) classified this species in Berger's section Epeteium in having biennial habit, 5-parted flowers with many seeded carpels, and young sterile shoots often forming loose rosettes. However, it is now understood that ten or more quite different species groups are comprised within his Epeteium which was mainly characterized by annual or biennial habit. Jansson considered this species to be related to *S. Roborowskii* Maxim., *S. Morotii* R.-Hamet and *S. formosanum* N. E. Brown. The former two which are regarded as the allies of *S. Oreades* greatly differ from this mainly in having ventrally straight (i.e. Orthocarpic) carpels. Certainly *S. formosanum* is somewhat related to this, but apparently differs by the free spurred sepals, the much broader nectar-scales, and the great number (more than 20) of ovules in each locule.

The closest relative of *S. victorianum* is undoubtedly *S. concarpum* Fröd. known from Likiang Snow Range in Yunnan (Fig. 2), especially in having basally connate, spurless sepals, higher connate ovaries and spathulate leaves. But, *S. concarpum* differs from this by the linear-subspathulate, 1.1 × 0.4 mm nectar-scales, the many seeded carpels, and the leaves with obtuse or round apex.

Tab. 1. Distribution ranges of Burmese species of Sedoideae.

GENUS	SPECIES \ REGION	Kashmir	Kumaon	Nepal	Sikkim	Bhutan	Tibet Assam	Burma	Yunnan	Szechuan	C.China
RHODIOLA	R. dumulosa						—	—	—	—	—
	R. chrysanthemifolia			—	—	—	—	—	—	—	
	R. macrocarpa							—	—	—	
	R. bupleuroides	—	—	—	—	—	—	—	—	—	
	R. nobilis							—	—		
	R. venusta						—	—	—	—	
	R. yunnanensis							—	—	—	
SEDUM	S. amplibracteatum							—	—	—	—
	S. filipes			—	—		—	—	—	—	—
	S. Kingdonii							—			
	S. Oreades	—	—	—	—	—	—	—	—		
	S. multicaule	—	—	—	—	—	—	—	—		
	S. victorianum							—			

Phytogeographical significance of Sedoideae in Mt. Victoria

As shown in Table 1, the Burmese species of Sedoideae are commonly distributed in Yunnan, except two local endemics of Mt. Victoria mentioned below. Geographically North Burma is obviously situated in the margin of the central Asiatic highland including the Himalayas, Tibetan Plateau, and Mountain ranges of S.W. China (Yunnan and Szechuan) (Fig. 2). Thus, it is very reasonable that the Sedoideae flora of North Burma apparently belongs to the same floral area with Yunnan.

Mt. Victoria (alt. 3053 m, See Fig. 2), located 21°12′ N & 93°35′ E, is the highest mountain in the tropical zone in Burma. The altitude of Mt. Victoria is theoretically considered to be lower to bear the real alpine vegetational belt in relation to latitude (Holdridge 1967). Actually there is no alpine climax, and temperate semi-evergreen forest continues to the summit, but only a number

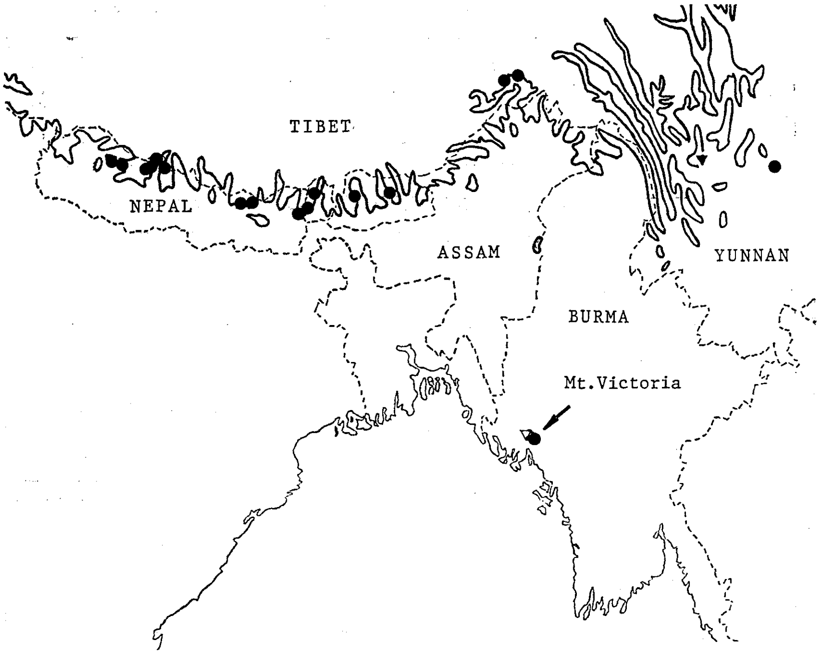

Fig. 2. Distribution of *Rhodiola chrysanthemifolia* (●), *Sedum victorianum* (▽) and *S. concarpum* (▼). Broader line shows the contour line of 3000 m in alt. of the central Asiatic highland.

of alpine plant grow on the exposed ledges and the open places (Kingdon-Ward 1958). Kingdon-Ward reported about 20 alpine species such as *Anemone obtusiloba* D. Don, *Primula denticulata* Smith, *Iris kamaonensis* Wall. ex D. Don, and *Campanula colorata* Wall. to occur there. At the summit of Mt. Victoria three species of Sedoideae are known: they are *Sedum Kingdonii* H. Ohba, *S. victorianum* Jansson, and *Rhodiola chrysanthemifolia* (Lév.) Fu. The former two are endemic to this mountain. The other species is distributed in the area from Nepal to Yunnan through Sikkim, Bhutan, Tibet, and Burma (Fig. 2). Mt. Victoria is obviously the southern limit of the generic distribution of *Rhodiola*. As shown in Fig. 2, the distribution of *R. chrysanthemifolia* is rather discontinuous. Especially Mt. Victoria is separated far from the main area of distribution along the contour line of 3000 m in alt. of the central Asiatic highland.

Generally, wind and drift are the principal carriers of seeds. Wind transport is now considered to be probably the most prevalent method by which plant surmounts the barriers of mountains and of straits of the sea (e.g. McLean & Ivimey-Cook 1973). In *Rhodiola*, though wind transport is highly effective to dispersion of seeds, the sudden changes of climate and vegetation owing to the altitudinal descent will be regarded as strong barriers. The isolated occurrence of *R. chrysanthemifolia* in Mt. Victoria is probably attributed to climatic changes in glacial period, and the population of Mt. Victoria may continue to flourish in the limited area in the climatic changes of post glacial period. *R. chrysanthemifolia* of Mt. Victoria is little different from it of other regions morphologically.

A very narrow endemic, *Sedum victorianum* is near to *S. concarpum* which was found in Likiang Snow Range, Yunnan (Fig. 2), and is apparently regarded as a morphologically close vicariant species (false vicariads by Vierhapper 1919, substitution taxa by Löve 1954). Another very narrowly endemic species, *S. Kingdonii*, is related to *S. Celiae* R.-Hamet known from S.W. China (Yunnan & Szechuan). Though *S. Kingdonii* is clearly distinguishable from *S. Celiae* by the lanceolate—narrowly ovate petals, the longer leaves, and the ovaries with 16-20 ovules, these two are also regarded as morphologically close vicariant species. In glacial period, some populations of their ancestral species, which had occupied the south-eastern part of the central Asiatic highland, extended southward. During post glacial period their populations of Mt. Victoria have flourished continuously, but other populations, at least in Burma, could not remain. As the result their populations of Mt. Victoria are isolated geographically. The evolution of these two Burmese species (*S. victorianum* & *S. Kingdonii*) seems to reflect earth history, principally climatic changes, and has taken place in step with changes.

The Sedoideae in Mt. Victoria will support the following interpretation: 1) During certain glacial period in past several species of Sedoideae had extended southward to tropical Burma from the central Asiatic highland along the ridges of the Burma Arc. 2) Since then two species of *Sedum* have differentiated morphologically, though others except for *Rhodiola chrysanthemifolia* have been extinct. 3) The differences between Burmese and their comparable species in other regions are morphologically regarded as vicarious stage in speciation.

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1975年にビルマ産マンネングサ亜科の分類を行いそれを名彙のかたちで発表した(Ohba 1975)。その後，故 Kingdon-Ward の採集品中に2種が新たに見つかり，また前報では検討できなかった特産種 *Sedum victorianum* Jansson を詳しく調べることができた。この間，マンネングサ亜科の分類システムの改訂を試みたので，このシステムによってビルマ産マンネングサ亜科の名彙の訂正と追加を行った。*Sedum Oreades* (Decne.) R.-Hamet と *Rhodiola dumulosa* (Franch.) Fu が今回ビルマに産することが判明したものである。*S. victorianum* については分類上最も重要と考える花葉の記載が不備だったのでこれを補った。またこの種が雲南省麗江で発見された *S. concarpum* Fröd. に近縁であることを明らかにした。

北緯 21°12′ に位置する Victoria 山 (海抜 3053 m) には特産の *Sedum victorianum* と *S. Kingdonii* H. Ohba のほか *Rhodiola chrysanthemifolia* (Lèv.) Fu を産する。この山はイワベンケイ属 (*Rhodiola*) の分布の南限になる。*Rhodiola* は現在の垂直分布から判断して高山帯を下って分布を拡げることができないと推論した。この推論に従って Victoria 山に産する *R. chrysanthemifolia* はその分布から氷河期の遺存と考えられる。また，*Sedum* の特産2種は雲南（または四川省を含む）に *S. concarpum* (*S. victorianum* に対応) と *S. Celiae* (*S. Kingdonii* に対応) の形態的に姉妹種とみられる対応種があり，氷河期に南下後形態的に姉妹種とみなせる段階にまで分化が進んだと考えられる。

ビルマ産のマンネングサ亜科はこの3種を除きみな北部ビルマに分布する。図2に標高 3000 m の等高線を示しておいた。この図から北部ビルマは地理的にアジア中央部の高地に連続していることが明らかである。Victoria 山に産する特産2種を除くビルマのマンネングサ亜科の種類はみな雲南にも分布しており，マンネングサ亜科の場合，区系の単位としてはビルマは雲南と同一であると考える。